Electronic Warfare / Electronic Protection (EW/EP)
S&T Priority Steering Council

28 November 2012

EW/EP Priority Steering Council
Scope & Domain Boundaries within the EMS

Electronic Warfare: **Military action involving the use of electromagnetic (EM) and directed energy to control the electromagnetic spectrum (EMS) or to attack the enemy.**

- **EP** — Protect EM systems against EM interference
- **Electromagnetic Spectrum Management**
- **EA** — Degrade, disrupt, deceive, & deny adversary EM system signals, processing, and C2 functions
  - **DE (EA)** — Induced currents or voltages
- **ES** — Tactical sensing for real-time response

- **PSYOP/MISO** — Induce alarms or failures / influence ideology
- **Counter-DE** — Protect non-EM system against EM interference and DE (Weapon)
- **C3** — Command, Control and Communications (voice, data, info)
- **DE (Weapon)** — Thermal / radiation bombardment
- **ISR/SIGINT** — Intelligence, Surveillance and Reconnaissance gathering systems
- **Cyber Attack** — Operations intended to manipulate adversary info and/or cyber systems

Role of the EW PSC

- **Be the EW S&T governance body for the Department**
- **Define cross-cutting investment strategy**
- **Develop experimentation strategy & recommendations**
- **Propose/define collaborations, e.g., integrated EW-Cyber effects**
- **Engage the community in its ENTIRETY**
  - Government, Industry, Academia, International
- **Develop seamless metrics across the partnerships**
  - How will we know we've met goals?
  - How do we know what level is good enough?
- **Incorporate (or reference) IRAD into PSC strategy/roadmaps**

Evolving Paradigm

- **PSC drive portfolio for the Components (Services)**
  - Air Force is the "Champion"
- **Provide focus Industry investments**
  - Industry seeks guidance
- **Drive new technical foundation**
  - E.g. Photonics, ultra high precision clocks, MMW

EW/EP Problem Statement
& Desired End State Capabilities

Rapidly evolving challenges to spectrum dominance threaten blue force lethality and survivability

Desired End State Capabilities:

Network-Enabled EW providing time-critical, effective ES/EA/EP via a **distributed, heterogeneous** EW system-of-systems architecture

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Adaptive EW for **real-time** assessment & deconfliction of the EMS, generation of EA/EP effects, & determination of EW effectiveness

Gap Analyses

Top-down View of System Challenges

Bottom-Up View of Enabling Components

Portfolio of Systems to allow a response, independent of the evolving threat

EW/EP Tech Challenges & Desired End States

- **TC1: Cognitive, Adaptive Capabilities**
  - Effectively outpace adversary decision and technical options
- **TC2: Coordinated / Distributed / Network-Enabled Systems**
  - Spatially and temporally diverse responsiveness to dense and complex threat environments
- **TC3: Preemptive / Proactive Effects**
  - Real-time sensing, assessment and optimization of EA effectiveness
- **TC4: Broadband / Multispectral Systems**
  - Widest possible spectral extent to our control of the EMS
- **TC5: Modular / Open / Software-Configurable Architectures**
  - Timely deployment or insertion of advanced EW in response to rapidly changing conditions
- **TC6: Advanced Electronic Protection Techniques & Technology**
  - Allow unfettered operations in the increasingly dense EMS environment

Dual Approach for Solutions

Top-down View of Critical Challenges

Precision EMS mapping	Precision timing, protocols, links	Predictive/ anticipatory algorithms	EO/IR ⇔ mmW ⇔ RF	Interface standards	STAR (Simultaneous Tx & Rx) → Extremely high isolation
M&S/DT&E					
TC1 Cognitive, Adaptive	**TC2** Distributed, Net-enabled	**TC3** Proactive, Pre-emptive	**TC4** Broadband, Multispectral	**TC5** Modular/Re-configurable H/w-S/w	**TC6** Adv EP Techniques/ Technology

Bottom-up View of Game-Changing Components: RF

- Agile, high dynamic range receiver electronics
- Ultra-wideband RF photonics
- RF power generation
- Underlying enabler: Ultra-precision clocks/ oscillators (Order of magnitude+ timing reference improvement))

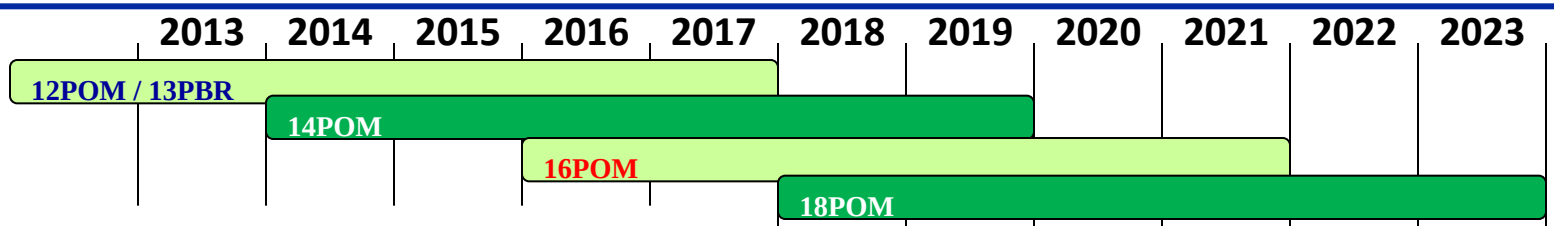
Bottom-up View of Game-Changing Components: EO/IR

- Next gen, multispectral infrared focal plane arrays
- Multi-spectral, high power lasers
- Multispectral optics/phase control
- Underlying electronics enabler: Nitride family of semiconductors (GaN/InN/AlN)

Bottoms-Up View of Enabling Components

STAR, Cognitive and Distributed/Networked capabilities are EW game-changers

Challenges for Community
(Candidate Technologies for Acceleration)



- **TC1** Cognitive, Adaptive
  - **Future Investment Areas Needed to Address Current Gaps:** Higher Level Cognition/Optimization, Real-time Behavioral Prediction, EW System Autonomy, Integrated EW & Cyber
- **TC2** Distributed, Net-Enabled
  - Adaptive Control Architectures, Wide-Area Coherent Processes, Scalable Network/Autonomous Control, Real-time Data Fusion
- **TC3** Proactive, Pre-emptive
  - Detect & DF LPI Signals, Real-time Adaptive/Predictive Tech, Intelligent Optimization, Tech to Anticipate/Influence Behavior
- **TC4** Broadband, Multispectral
  - Ultra-Wideband/Full Spectrum/Spectrum Agnostic Technologies, Multi-layered Multispectral Deception & Signature Suppression
- **TC5** Modular/Re-configurable H/w-S/w
  - Joint Open Architecture Standards, MIMO EW Methods, Real-time Adaptive Reconfigurabilty/Reprogrammability
- **TC6** Advanced EP
  - Truly Simultaneous Transmit & Receive (STAR), Low-Noise Adapt Cancellation, Real-time Sub-Signal Artifact ID, Quantum Security

Rqmts Pull

Tech Push

2012-13 PSC Update

- **Advanced Components for EW (ACE) Goal: To be "MMIC"-like program**
  - Integrated Photonic Circuits (IPC)
  - MMW Source & Receiver Components
  - Reconfigurable, Adaptive RF Electronics (RARE)
  - 3D-Heterogeneous Integration of Photonics Sources (3D-HIPS)
- **ASD(R&E) Comprehensive Review identified areas for potential acceleration**
  - Integrated EW/Cyber Effects (likely joint with Cyber PSC)
  - Adaptive Control Architectures/Scalable Network/Autonomous Control (possibly joint with Autonomy PSC)
  - Real-time Adaptivity – ES, EA, EP
  - Simultaneous Transmit & Receive (STAR)
- **Incorporate identified system challenges, acceleration areas, and enabling components into the PSC's 6 TC roadmaps, overlayed with rigorous technical metrics and transition off-ramp opportunities**

Summary

- **Electronic Warfare is a critical enabler for air, land, sea, space, and cyber operations**
- **2011-2012 analyses converged on a consistent list of long term game-changing tech challenges…**
  - Cognitive capabilities
  - Networked, distributed, coherent systems
  - Real-time adaptive capabilities
  - Simultaneous Tx & Rx (STAR)
  - … Enabled by highly linear, agile, high dynamic range, ultra-wideband / multispectral transmit & receive components, precision clocks/oscillators, and phase-controlled apertures
- **Roadmaps being re-configured with metrics to achieve an integrated EW systems/components and warfighter transition investment strategy**

EW/EP PSC Membership

Champion:	**USAF (SAF/AQR)**
PSC Lead:	**Mr. David Hime**
OSD:	**Mr Jay Kistler, Dr. Karl Dahlhauser --** ASD(R&E)
Air Force:	**Mr. David Hime** (Lead)**, Mr. Marv Potts, Mr. Joe Koesters**
Army:	**Dr. Paul Zablocky** (Lead)**, Dr. Leslie Litton, Mr. Bill Taylor**
Navy:	**Dr. Peter Craig** (Lead) **, Dr. Frank Klemm, Dr. Gerry Borsuk**

ACE Technology Analysis and Planning (TAP) Service Leaders

ACE TAP Lead:	**Dr. Gerry Borsuk, NRL**
Air Force:	**Dr. Stephen Hary, AFRL**
Army:	**Dr. Eric Adler, ARL**
Navy:	**Dr. Stephen Pappert, ONR**
DARPA:	**Dr. Bruce Wallace**

Broad Agency Announcements

- **Industry responses to the grand challenges identified in this brief should engage in dialogue with the PSC leadership**
- **The following Broad Agency Announcements (BAAs) may also provide an avenue for specific ideas:**

- **Air Force**
  - BAA 09-01-PKS: “Sensor Technology Research, Development, Test & Evaluation Open-Ended Broad Agency Announcement (STROEB) II”
- **Army**
  - BAA W15P7T-09-R-S152: "United States Army Communications-Electronics Research Development and Engineering Command Intelligence and Information Warfare Directorate Broad Agency Announcement I2WD 2009“
- **Navy**
  - BAA ONR 13-001: “Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology”